KRONOS
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Because you matter.

Sustainability at KRONOS ecochem

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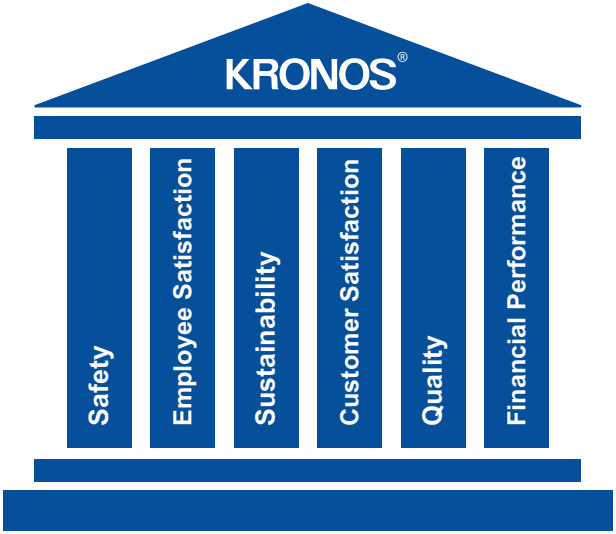
Colours are primary elements in our everyday lives. And white pigments play a special role because they can lighten any other colour, but also increase opacity. And with higher opacity, material coatings can be applied more thinly to conserve resources. The raw materials required to produce titanium dioxide (TiO_2), today's most widely-used white pigment, occur in nature in various minerals. Titanium is one of the ten, most-common elements in the earth's crust.

Production of TiO_2 for use as a highly white pigment in a wide range of applications has been the core business of KRONOS and its predecessors since 1916. Lead sulfate and white lead, the white pigments conventionally used in paints and coatings up until 1923, were banned thereafter because of their toxicity and replaced by modern alternatives, such as titanium dioxide.

As the oldest TiO_2 producer worldwide – and one of the largest, with a market share of 11 % – KRONOS today is a leader in quality and innovation. The company has over 2,200 employees at six production sites and a company-owned mine.

Sustainability (see infobox) is one of the six pillars on which KRONOS is built. To promote sustainable success, KRONOS has established an integrated management system for safety (including food safety), environment, energy, and quality. This system undergoes continuous improvement and all certifications for it are renewed on a regular basis (www.kronosecochem.com).

KRONOS ecochem has been a proponent of sustainability ever since it was founded in 1974 as KRONOS Water Treatment Chemicals. It was set up as an independent division of KRONOS to put unavoidable by-products to effective use in line with the principles of a circular economy.



What does "sustainability" mean?

The UN World Commission on Environment and Development 1987: "Sustainable development is development that meets the needs of the present generation without compromising the ability of future generations to meet their needs."

Sustainability means development that gives consideration to environmental protection, social equity and economic viability. These elements are also referred to as the "3 pillars of sustainability," and the objective of this model is to implement all three areas simultaneously and equitably.

The concept of "sustainability" was first used in 1713 by Hans Carl von Carlowitz in reference to forestry: "In a forest, only so much wood should be cut as can be regrown, so as to ensure survival of the forest in the future."

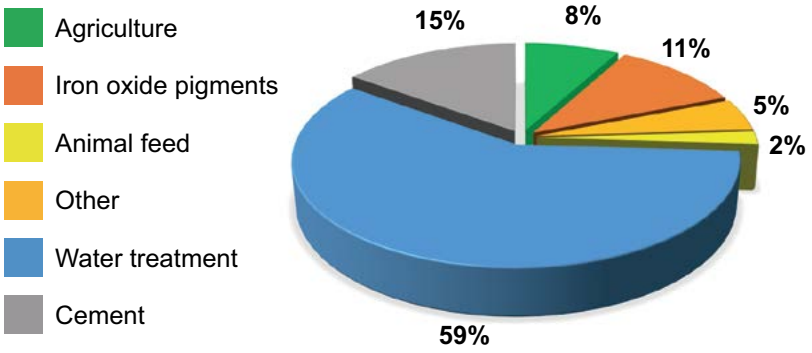
It all began with the sale of ferrous sulfate for wastewater treatment. In time, further applications for iron sulfates, iron chlorides and other by-products were developed. Its current name, KRONOS ecochem, reflects the diverse ways in which using by-products fulfills both the ecological and economic requirements of a circular economy.

As part of the KRONOS family, KRONOS ecochem is committed to its integrated management system and to exemplifying the philosophy we live by. For instance, we have regional teams of sales professionals and technical service specialists, which reduces the travel involved in visiting customers. Combined freight transports, which take advantage of the railway infrastructure for long distances and freight-optimized offices of departure, are another element of our sustainable business practices.

In the first year of business after it was founded, KRONOS ecochem successfully sold some 40,000 tons of iron sulfate by-product on the market.

Today, 50 years later, Executive Management, Sales, Logistics and Technical Services have a total of 25 employees partnering with KRONOS ecochem customers, supplying them with 750,000 tons of iron salts a year and supporting their individual applications. These products are primarily used in waste water treatment (phosphate and H_2S elimination, flocculation, sludge conditioning), industrial effluent treatment and drinking water purification, as raw materials for iron oxide pigments, in the reduction of the harmful substance chromate in cement, and in agriculture (see diagram). These areas of application clearly show that most KRONOS ecochem products serve sustainable purposes that benefit people and the environment.

Applications of iron salt products



The climate relevance of KRONOS ecochem products

As KRONOS' main business activity is focused on the production and sale of titanium dioxide, the company's climate-relevant emissions associated with the entire production process are sensibly divided between titanium dioxide and the by-products. This involves comparing the current sales values of the respective production volumes of main and by-products. The carbon footprint of the individual products is therefore by definition also dependent on their current market values and sales volumes and can therefore only represent a snapshot.

In an industry-specific study*[1] from October 2023, iron sulphate from titanium dioxide production was attributed a share of 3.4% of total emissions from the sulphate process.

What is a Life Cycle Assessment (LCA)?

The Life Cycle Assessment, also life cycle analy-sis, is a systematic analysis of environmental impacts attributed to every stage of a product or service (cradle-to-grave).

In accordance with EN ISO 14040, the analysis includes all raw materials, transport, production processes, and use, disposal and recycling that are associated with a product.

What is the CO_2 footprint?

The CO_2 footprint or carbon footprint is a specific application of the LCA method. It is a measure of total climate-relevant emissions generated or caused directly or indirectly by a product or an individual. Apart from carbon dioxide, there are other gases (e.g. methane, nitrous oxide) that contribute significantly to global warming. To calculate the CO_2 equivalent (CO_2e), the quantity of all these greenhouse gases is converted to the corresponding quantity of CO_2 with the same warming potential, as if only CO_2 were emitted, so that the impact of total emissions on the climate can be compared.

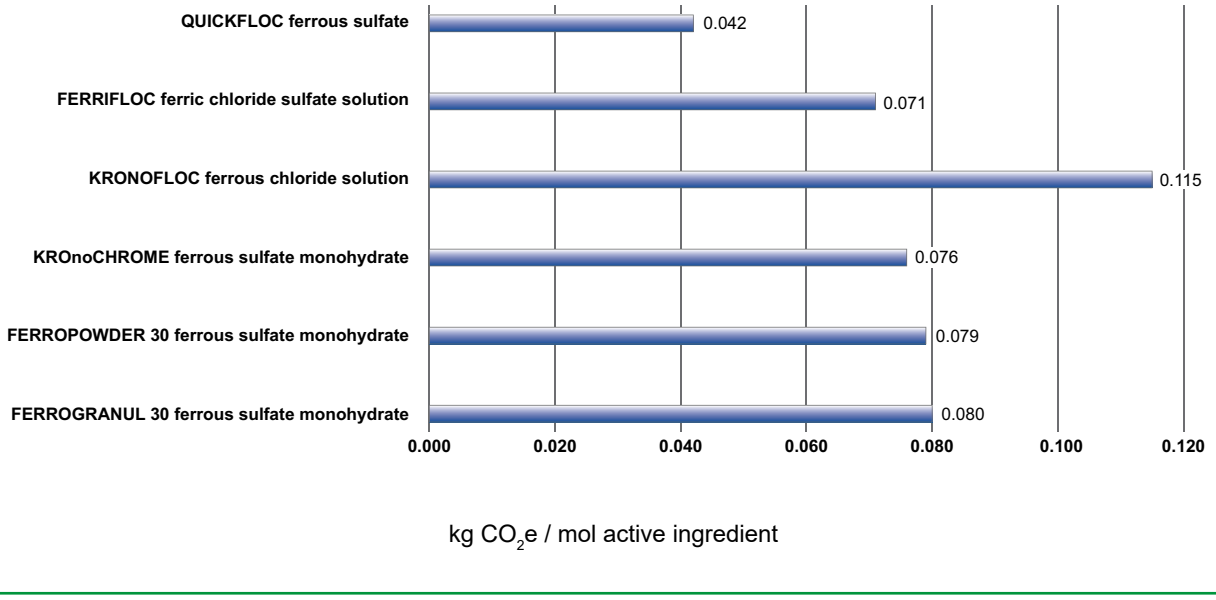
*[1] Kristin Johansson, Anna Liljenroth: Carbon footprints of inorganic coagulants, IVL Report U6780, Swedish Environmental Institute, October 2023

As a result, QUICKFLOC ferrous sulphate has a current CO_2 footprint of 0.134 g / kg product. Further product processing (e.g. drying ferrous sulphate into free-flowing products or chlorination into FERRIFLOC ferric chloride sulphate solution) and transport result in additional greenhouse gas emissions, which are directly and fully attributed to KRONOS ecochem products.

Using this approach, the current carbon footprint for the production of the FERRIFLOC ferric chloride sulphate solution, for example, is 0.071 kg CO_2e per mole of Fe(III), which corresponds to 156 g CO_2e per kg of FERRIFLOC. A quantity of 4 kg of FERRIFLOC is sufficient on average to ensure phosphate elimination in a municipal sewage treatment plant in Germany per inhabitant for a whole year. The climate impact per inhabitant and year through the use of FERRIFLOC as a precipitant is therefore roughly equivalent to the climate impact of 8 cups of coffee or that of driving around 4 km in a car with an internal combustion engine.

Phosphate elimination per person and year (4 kg FERRIFLOC) ≙ **8 cups of coffee** ≙ **4 km by car**

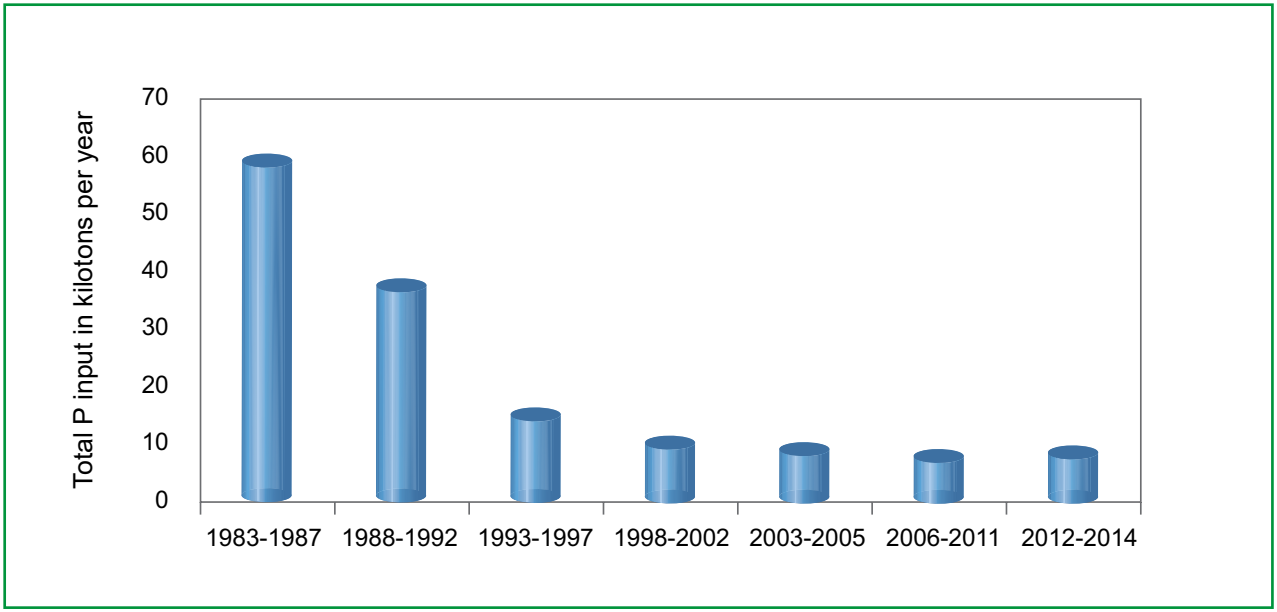
Current CO_2 footprint of KRONOS ecochem products



Examples of the environmental benefits

KRONOS ecochem supplies iron salts for phosphate elimination, helping significantly to protect surface waters (see the diagram) and recover and re-use phosphorus, as called for in the sustainability strategy.

The observing of defined phosphorus limits to protect surface waters and the recycling of **phosphorus** as a critical resource in food production is, among other things, a declared goal of the Water Framework Directive 2000/60/EC.

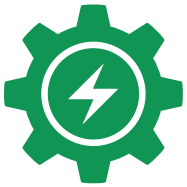


Total phosphorus inputs from point sources in surface waters in Germany in kilotons per year (Source: German Environment Agency 2016)

KRONOS is committed to reducing and minimizing its impact on the environment as far as possible by means of continuous assessment and development.

Several examples of the successful implementation of this guiding principle:

Electric power for the company's ilmenite mine and for mineral processing is eco-friendly and climate-neutral, because it has been generated from the very beginning by a KRONOS-owned hydroelectric power plant. The first hydroelectric plant, built in 1907, was replaced in 2009 by a new, more efficient system with a 4.5 MW turbine.



Ever since KRONOS launched operation of its gas/steam turbine combined-cycle power plant (GTCC) in 2014, the Nordenham site has been producing its own electric power and superheated steam for production, cutting energy costs and some 30,000 tons of CO_2 a year.

Since 1989, the sulfuric acid required for digestion and subsequent production steps has been recovered, concentrated and returned to the digestion process. This method has minimized waste and reduced the demand for fresh sulfuric acid by nearly 40%.

In addition, since 2005 the company has been turning the filter salts produced in the sulfuric acid recycling process into a product called "KROnoCHROME", which is used in the cement industry to reduce the harmful substance chromate. KRONOS ecochem alone sells 75,000 tons of free-flowing iron sulfate yearly to customers for this application. About 0.3% iron sulfate is added to the cement on average. The percentage of cement clinker, the main contributor to cement's CO_2 footprint, decreases accordingly, meaning that adding iron sulfate – apart from its actual purpose of chromate reduction – also lowers CO_2 by about 35,000 tons per year.

Another resource conservation project won the 2009 Responsible Care Award of the northern chapter of the German Chemical Industry Association (VCI Nord). KRONOS was recognized for developing a method for receiving, processing and re-using a sodium aluminate solution generated as production waste at an aircraft plant operated by Premium Aerotec (formerly Airbus) in Nordenham, Germany. In turn, KRONOS Nordenham was able to reduce consumption of aluminum oxide and sodium hydroxide by the corresponding amounts on a regular basis.

Looking into the future

Sustainability depends on many different factors. But what does that mean in concrete terms for KRONOS ecochem? What future goals and tasks will our company face with its commitment to sustainability? We can surely find ways to further improve the sustainability of processes in all our spheres of activity, from raw material extraction to the use of our products by customers.

With these aims in mind, KRONOS ecochem has established a working group for climate protection that is studying this important issue in-depth and developing and pursuing new ideas.

The working group intends to post progress reports on the KRONOS ecochem website and release information on new projects.

Achieving sustainability is an ambitious goal, one that requires fundamental changes in our ways of thinking and our actions. We will keep our sights set on sustainability, while striving to continuously improve our processes.

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